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ABSTRACT

Text, illustrations, and exercises are utilized in these five learning modules to instruct nursing students in techniques for initiating intravenous (I.V.) therapy. The first module, "Selection of a Venipuncture Site: Arm" by P. Allen Gray, Jr., describes the utilization of a tourniquet in locating filled veins in the arm. The second module, "Selecting a Needle and Venipuncture Site for Intravenous Therapy" by Carolyn Jane Mueller, discusses the appropriate use of scalp vein needles and catheters, and examines the selection and preparation of an injection site. The third module, "Starting an I.V." by Betty L. Temples, reviews the selection of an insertion site, factors in choosing proper needle and vessel sizes, and the correct positioning of the needle vis-a-vis the vein. The fourth module, "Techniques in Starting Intravenous Therapy" by J. Sue Beldin, describes equipment and needles used in I.V. therapy, the emotional and physical preparation of the patient, steps in securing the I.V. needle and tube, and follow-up procedures. The fifth module, "Calculating the Rate of Flow of Intravenous Fluids" by Cynthia A. Hulse, requires the student to solve problems requiring the use of relevant formulas. Each of the modules describes and illustrates procedures, provides reinforcement exercises, and concludes with a post-test. The time required to complete the modules ranges from 20 to 60 minutes. (JP)

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HEALTH INSTRUCTION PACKAGES:

Ventipuncture and Intravenous Therapy

Modules prepared by:

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SELECTION OF A VENIPUNCTURE SITE: ARM

by

P. Allen Gray, Jr., R.N.

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TITLE OF PACKAGE:	Selection of a Venipuncture Site : Arm
AUTHOR:	P. Allen Gray, R.N., M.S.N.
INSTITUTION:	North Carolina Memorial Hospital
INTENDED STUDENTS:	Community College Nursing Students
ESTIMATED WORKING TIME:	20 minutes
MATERIALS NEEDED:	Rubber (Or other Elastic) band or flat rubber tubing, long enough to be wrapped around upper arm.
REVISED:	March 1, 1978

NOTE:

This package is ideal for use by two or more persons who can take turns being the patient or subject.

If one person is working through the package alone, he/she should practice the procedures on his/her arm.

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In this package you will learn the general information necessary for selecting sites for venipuncture.

OBJECTIVES

The overall objective of this package is to enable you to select an appropriate site for venipuncture. In achieving this objective you will need to accomplish several sub-steps.

1. You will apply a tourniquet to a person's arm.
2. You will demonstrate a filled vein on a person's forearm.
3. You will point out three areas on the forearm where venipuncture may be done.

PROCEDURE

A tourniquet is a rubber (or other elastic) band or tube which is long enough to be wrapped around a person's upper arm. A flat rubber tubing, such as a penrose drain, makes a very effective tourniquet.

A properly applied tourniquet should be looped around the arm rather than tied. This practice makes it easier to remove the tourniquet. It should be just tight enough to keep the blood from flowing through the veins, but not tight enough to keep the blood from flowing through the arteries of the arm. If you can still feel a radial pulse (near the base of the thumb) after the tourniquet is applied, it is not too tight. (If you have difficulty in finding the radial pulse, it is on the thumb side of the wrist, just above the wrist joint). The forearm is usually extended on a table, desk, or other flat surface so that your work can proceed more easily.

Now, you should be ready to apply a tourniquet yourself. Consider these steps to be followed as you put the tourniquet on your patient.

1.) Pick up the tourniquet and stretch it around the arm of the patient. Picture #1, below, shows how this first step should be done.

Picture #1

2. Push a loop of the tourniquet under the circle around the patient's arm so that the tourniquet remains in place without actually being tied. A correctly placed and looped tourniquet is shown in Picture #2 below. Notice that an index finger has pushed a loop of the tourniquet under the circle around the patient's arm.

3. Remove the tourniquet by pulling on the free end which was tucked under. If the tourniquet was looped properly, it will snap off as soon as it is pulled.

You may wish to practice these steps several times before you go on with the package. Remember, you were successful in your attempts to apply a tourniquet if:

1. you placed the tourniquet like the one in Picture #1,
2. the tourniquet remained in place with a loop like that in Picture #2,
3. the pulse could still be felt,
4. you notice bulging veins.

Now that you can apply a tourniquet, it will be necessary for you to be able to identify veins before you can insert needles into them. When the tourniquet is tight enough to stop blood flow in the veins, but not in the arteries, the veins will fill with blood and stand out on the arm like cords. You should be able to trace these cord-like swellings down the arm; they may branch off into a number of smaller cords as you look from the elbow to the hand. Picture #3 at the top of the next page shows how a vein on a person's forearm may look.

Picture # 3

Sometimes it is difficult to see veins on people who have much fat just under their skin. If you cannot see veins on your patient's forearm, feel for these cord-like structures along the surface of the arm. Often veins which cannot be seen can be felt.

When veins are slow to fill, it is usually helpful to have the patient open and close his fist or to squeeze something in his hand. You might also suggest that he let his arm hang down by his side for a few seconds. All these measures make more blood available for filling the veins which have been closed by the tourniquet.

Now apply the tourniquet to the arm of a patient and look for filled veins. If you do not see veins, feel for cord-like structures under the skin in the areas where you might expect to see veins.

If you could see, or feel, several raised, cord-like swellings on the arm of the patient after the tourniquet was applied, you were successful in locating filled veins.

Since you are now able to apply a tourniquet and to identify filled veins, you are making a great deal of progress toward being ready to do venipunctures. You now need to know where venipunctures usually are done, or can be done. The vein to be used should be large enough to allow the insertion of a needle, and it should be identifiable for about one inch by sight or touch. There are three main sections of the forearm where veins suitable for venpuncture are located.

1. At the bend of the elbow there are large veins which are usually easy to see or feel.
2. On the mid-portion of the forearm there usually are some veins which can be seen or felt. The location of these veins varies from person to person.
3. Near the wrist there are veins on the thumb side of the forearm which are often easy to see or feel.

Now look at the illustration, Picture # 4, below. From what you have learned about veins and their usual locations can you make a statement about the picture?

Picture # 4

If you said it is a picture of a filled vein, or a picture of a vein near the wrist on the thumb-side of the forearm, you were correct. Can you remember the other two areas where veins may be located for venipuncture? You can get a hint from Picture #3.

Now find filled veins in each of these three areas on your patient by sight or touch. Look at the elbow, near the wrist, and along the mid-portion of the forearm.

If you felt or saw veins which would allow the admission of a needle, that is, at least one inch of vein, in each of these three areas, you were successful.

These skills which you have been developing can be used on anyone who needs to have a venipuncture done for any reason. You now should be able to locate venipuncture sites on almost any person. Remember, though, that it is not always possible to locate veins easily. Some people have veins which are so well hidden that they are difficult to find. Even the experts have trouble finding venipuncture sites on these people.

Now, before you take the post-test, you might like to try finding three possible sites for venipuncture on yourself or some other person than the one on whom you learned.

Did you remember:

1. to apply the tourniquet properly,
2. to locate filled veins,
3. to identify veins in the three areas which were described as suitable for venipuncture?

POST-TEST

As you complete each of the following exercises, record your performance on the ANSWER SHEET provided.

Exercise # 1) Apply a tourniquet to the arm of any person. (f you're working alone, apply the tourniquet to your own arm.)

2) Identify at least two filled veins on the forearm. (Veins may be identified by sight or touch.)

3) Locate three possible sites for venipuncture.

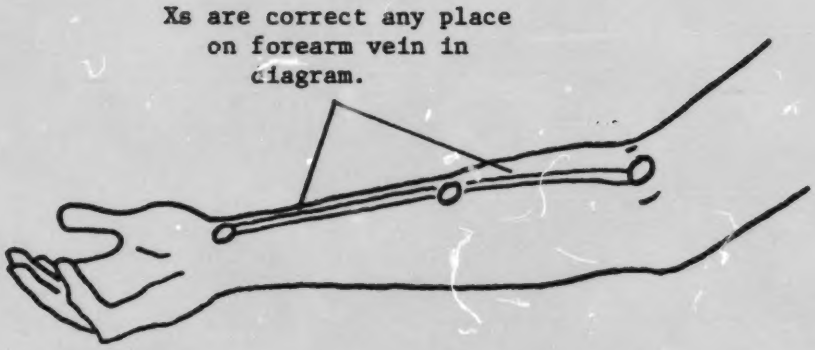
AFTER YOU'VE COMPLETED THE POST-TEST AND RECORDED YOUR PERFORMANCE, CHECK PAGE 8 TO SEE HOW YOU'VE DONE.

CHECK YOUR POST-TEST PERFORMANCE:

Exercise # 1) If you were able to answer "YES" to all three questions, your application of the tourniquet was satisfactory.

Exercise # 2) If you answered "YES" and were able to mark at least two "X's" on the diagram, your performance on this exercise was satisfactory. You should have been able to see or feel cord-like bulges or swellings on the arm.

Exercise # 3) The three possible sites are: bend of the elbow; mid-portion of the forearm; near the wrist on the thumb side of the forearm. (SEE DIAGRAM BELOW.)



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SELECTING A NEEDLE AND VENIPUNCTURE SITE FOR INTRAVENOUS THERAPY

By

Carolyn Jane Mueller

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TITLE:	Selecting a Needle and Venipuncture Site for Intravenous Therapy
AUTHOR:	Carolyn Jane Mueller
INSTITUTION:	Tucson Medical Center, Tucson, Ariz.
INTENDED STUDENTS:	Nursing (R.N. needing review)
ESTIMATED WORKING TIME:	20 minutes
MATERIALS NEEDED:	A Colleague to work with and an alcohol or iodophor swab.

FIELD TEST COPY

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INTRODUCTION

Do you know what points to consider when selecting a needle in choosing a venipuncture site? If you are working in a health care facility you probably have some knowledge of the purpose of intravenous therapy and the equipment needed to perform a venipuncture.

Before starting an intravenous, check the type of solution to be used and the duration of therapy. Then check the patient to determine the type of needle to use and to select the best insertion site. If the therapy is of short duration you may use a scalp vein needle and a vein on the dorsal aspect of the hand. If the therapy is long-term you will probably use a catheter and a larger lumen vein.

This package is designed to assist you in the selection of a needle and venipuncture site.

OBJECTIVES OF UNIT

Overall Objective

The student will demonstrate his ability to select an intravenous needle and venipuncture site.

Sub-Objectives

With the assistance of a colleague:

1. Verbalize knowledge of intravenous therapy
2. Select the proper type and size of needle to use by listing the main reason for the infusion.
3. List factors to be considered in selecting a venipuncture site.
4. Using your colleague's arm, prepare the site for the insertion.

PRACTICE EXERCISE #1

Intravenous therapy is used for replacing fluids, electrolytes, blood and its derivatives to the body by inserting a needle or catheter into a vein and letting the fluid enter at a specified rate of flow. The intravenous route is used when the oral route cannot be used.

Practice Question #1

In your own words define intravenous therapy and two reasons for giving intravenous fluids.

Feedback

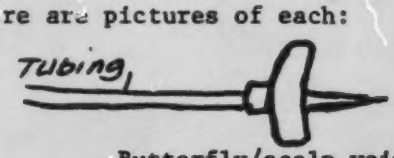
If you said that intravenous therapy is used for replacing body fluids through the use of the veins and replacement fluids include electrolytes, blood and its derivatives, and supplemental nourishment, you answered correctly.

PRACTICE EXERCISE #2

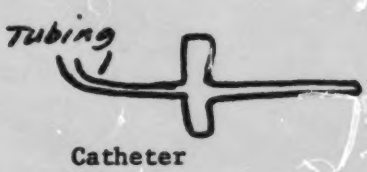
The next step is to determine the type of needle you will use. In order to make a choice you must know the purpose for the infusion and the condition and availability of a vein. A catheter (plastic needle) is used for long-term therapy, when veins become exhausted from prolonged therapy, and when the vein collapses from shock.

A scalp vein needle, sometimes called a "butterfly" (metal), is used for short term therapy. This type has a large lumen with a smaller needle diameter and the short bevel reduces the risk of infiltration. The flat wings are held together when inserting the needle and opened flat onto the skin after insertion.

Here are pictures of each:



Butterfly/scalp vein



Catheter

Practice Question #2

Name 2 types of needles and explain when each is used.

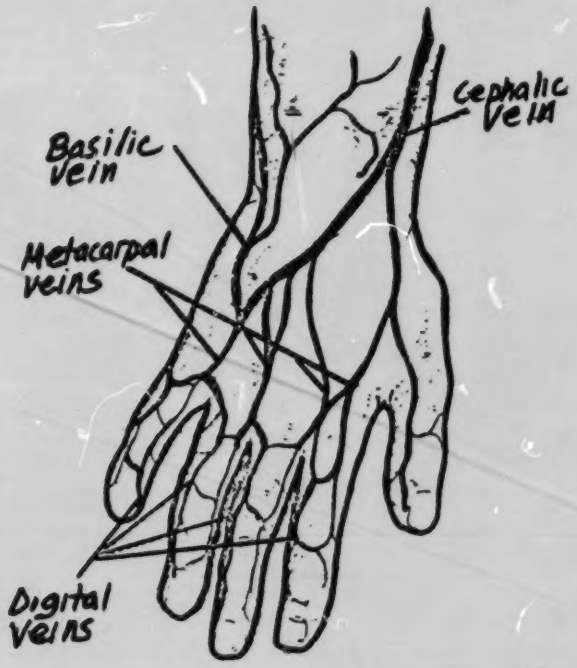
Feedback

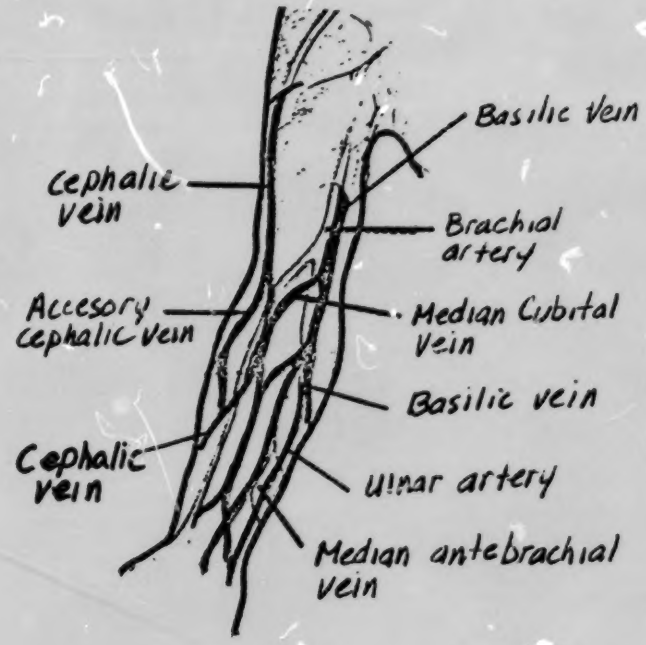
Two types of needles are:

1) Scalp vein (metal)
2) Catheter

A scalp vein needle is usually used for short term therapy and a catheter for long term therapy. You will also have to consider the condition and availability of the vein.

To assist you in selecting a venipuncture site I am including illustrations of superficial veins of the dorsal aspect of the hand and those of the inner aspect of the forearm.





Look at both hands and arms before selecting a site. You will also need to consider the following: when a patient is having surgery do not use the extremity on the same side, use the opposite one; use a vein in the hand before one in the forearm, if you blow the vein you cannot go distal (below) to that site as there will probably be leakage and perhaps inflammation; avoid joint areas causing immobilization.

In the elderly, veins may be small and thin and will not dilate sufficiently; palpate the vein to determine if it is thrombosed or rolls easily. When palpating a vein, use the tips of the fingers as they soon become sensory sensitive.

You must also consider the purpose of the infusion. When large quantities of fluids must be infused rapidly or those of high viscosity are given, select a large lumen vein. Solutions containing irritating drugs also require a larger vein. You will also need to know the duration of therapy. When continuous therapy is used, you must select distal veins first.

Practice Question #3

What factors will you consider when selecting a venipuncture site?

Feedback

If you listed the following:

1) Duration of infusion
2) Purpose of infusion
3) Suitable location
4) Condition of vein

you are on the right track. However, you might want to elaborate on each.

When a long term therapy is required, I would select one of the larger distal veins, not over a joint causing limited motion. A large lumen vein is needed when therapy includes giving blood or blood products and fluids with high viscosity. Palpating the vein will tell me if the vein is thrombosed, or rolls easily.

Now that you have selected the venipuncture site and have all the necessary equipment, you are ready to cleanse the site with an alcohol or iodophor swab and a circular motion. Briskly rub the skin for one to two minutes, beginning at insertion site and moving outward approximately 2 inches. Allow area to dry for 1 ½ minutes. (See diagram.)

Cleansing the skin removes superficial bacteria, thus reducing the possibility of bacteria entering the blood stream.

Practice Question #4

Demonstrate on a colleague the procedure for preparing the injection site.

Feedback

Using an iodophor or alcohol swab and a circular motion, briskly rub the skin beginning at the insertion site and moving outward for approximately 2 inches for 1½ to 2 minutes. Let air dry before inserting needle.

Now that you have completed this packet, you should feel very comfortable in selecting a venipuncture site and needle. Perhaps you would like to try the next packet on "Performing a Venipuncture."

POST-TEST

1. State briefly the purpose of intravenous therapy.

2. Describe 2 types of needles and when each is used.

3. List 3 or 4 factors to be considered when selecting a venipuncture site.

4. With the assistance of a colleague demonstrate the steps to follow when preparing the site for insertion.

1. The purpose of intravenous therapy is to replace fluid loss, to assist in maintaining electrolytes and provide supplemental nourishment when a person is unable to take fluids and/or food orally. Blood is also given intravenously.

2. Two types of needles are: metal needle and catheter. A metal needle is usually used for short term therapy. A catheter is used for long term therapy. Needles or catheters with a large lumen are needed for solutions with a high viscosity and a smaller lumen for solutions with a low viscosity.

3. Factors to consider when selecting a vein include:

   a. Duration of infusion - short or long term.

   b. Purpose of infusion - blood and blood products (high viscosity) need a larger lumen needle and therefore a larger vein.

   c. Suitable location - try not to select a site over a joint.

   d. Condition of vein - do not use thrombosed veins or areas close to valves.

4. Site preparation: Using an alcohol or iodophor swab and a circular motion briskly rub the skin at the insertion site and moving outward for approximately 2 inches for 1½ to 2 minutes.

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STARTING AN I. V.

by

Betty L. Temples

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TITLE OF PACKAGE:	Starting an I.V.
AUTHOR:	Betty L. Temples
INSTITUTION:	Southern Illinois University, Edwardsville, Ill.
INTENDED STUDENTS:	Nursing
ESTIMATED WORKING TIME:	60 minutes
MATERIALS NEEDED:	A partner; simulated hand and arm Trainex Simulator-Model LF698, Serial # 303 Medical Injectable Training Arm); tourniquet; 5 cc syringe; needles #25,23,21,18,16; alcohol wipes

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NOTE: You should have a working knowledge of aseptic technique before proceeding with this unit. Other units supplement this.

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INTRODUCTION

Many patients in health facilities receive intravenous fluids. It is important in certain situations that nurses be able to start an I. V.

The following instructions have been prepared for you to gain knowledge and practice starting I. V.s. Before starting the instructions, please refer to the title page and make sure you have all the equipment listed. When all the materials are before you, begin.

Turn the page

OBJECTIVE OF UNIT

Overall Objective

When finished you will be able to - correctly insert a needle into a vessel to start an I.V. or draw blood.

Sub-Objectives

- locate three (3) veins that may be used for I.V. infusion from a diagram and on a simulated person.
- determine if the vein has elasticity or is thrombosed by feeling a simulated example of each.
- apply a tourniquet above the I.V. insertion site.
- choose the correct needle size for the vein from a group of needles provided.
- position needle bevel correctly for the size of vein.
- given a simulated patient, practice inserting the needle into a vein.
- list any benefits gained by the unit materials.
- verbalize more confidence of own skills when inserting a needle to start an I.V. or draw blood.

PRACTICE EXERCISE #1

Read through the following five steps, then repeat stopping where there is an (*) and do the activity.

1. Position your hand and arm in a dependent position. A dependent position is one in which the blood will pool or remain in an area for a longer time than usual. (Hang your extremity loosely toward the floor.)*

2. After a few seconds, the veins in the extremity should be distended. Sometimes you will be able to clearly see them. Look to see if you can.*

3. Usually, veins of larger diameter, under greater pressure, and nearer the skin will be more obvious.

4. Now use the simulated hand and arm. Starting near the fingers trace the route of veins up the hand and arm by lightly touching the vessel with the tip of your other index finger - use a light tapping motion.*

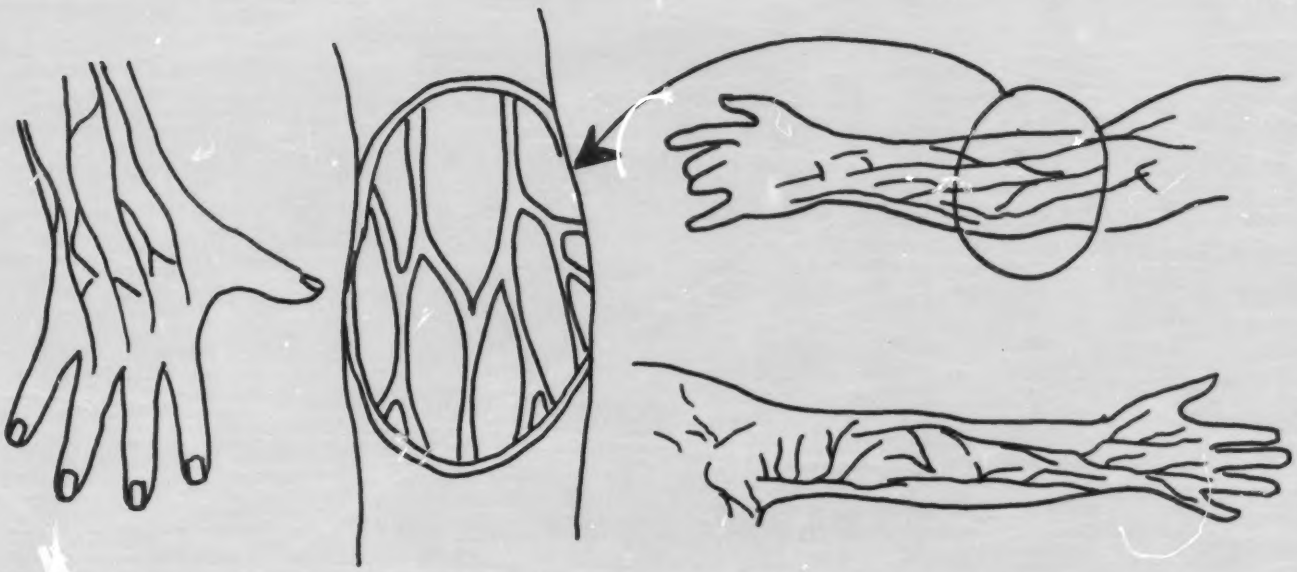
5. Look at the diagrams below.* Are the veins in the hand and arm in similar places? Don't panic - they are there!! Look again.* Feel them.

The check marks emphasize the veins commonly used to start an I.V. infusion.

Practice Question #1

1) Using a simulated partner (the IV arm), locate veins in the hand and arm that may be commonly used to start an I.V. by palpating the areas shown earlier in the diagrams. Refer to the bottom diagrams if necessary. Try without them.

2) On the blank diagrams below, indicate with an X at least three (3) veins that can be used to start an I.V. infusion.



-5- TURN THE PAGE FOR ANSWERS

Feedback

You are correct if your diagrams have (X) in any three of the locations checked in the diagram.

PRACTICE EXERCISE #2

You have already practiced palpating a vein in the hand and arm. If you need to review this - do it now. Do you remember that the vein felt spongy under your light tapping touch? Try it again. Now with your hand positioned in front of you with the palm toward the floor, spread your fingers and point them toward the ceiling. So far so good!!! At the base of your fingers where they attach to your hand, you should see tendons. They look like little ropes. Palpate these just like you did the veins. Feels a little different doesn't it!!

If a vein feels more like the tendon at intervals, it is probably thrombosed. It has lost its elastic properties somewhere along its route.

Practice Question #2:

Explain some differences in the feel of a healthy vein and a thrombosed veins. Check the next page for the answer.

Feedback

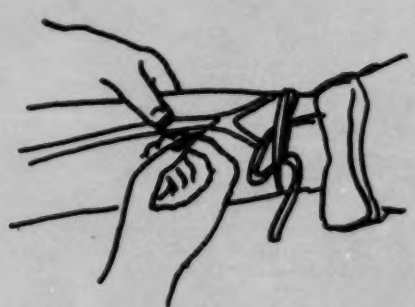
You are correct if you have included that a healthy veins feels spongy or elastic while a thrombosed vein feels hard and bympy.

Good! Keep Going!!!

PRACTICE EXERCISE #3

Read the complete input - then practice and refer back to the steps. Find the tourniquet in the equipment. Feel and handle it. Notice a tourniquet is made of stretchy material. It is used to occlude some of the blood flow in the arm above where you will put the needle. (See drawing below.)

Now - practice putting it on the simulated arm. Your tourniquet should be out of your way with the ends of it extending upward. If the ends of the tourniquet drape down into your field of work, then you've tucked under the wrong side. If you need to - try it until it looks like the picture below. Getting fun - uh?? Don't get frustrated - you can do it. Make sure you have used a little of the stretch so the tourniquet is a little tight on the arm.



Practice Question #3:

Now, let's have you do it. Apply a tourniquet so it is positioned correctly above the insertion site you have decided upon.

Before going further - check your answer by looking on the next page.

Feedback

If you have the tourniquet on so the ends of it are out of your way and you've used some of the stretch, then it should look something like this. Does it?? Good!

PRACTICE EXERCISE #4

A size of the needle used will depend upon multiple factors. Right now, what you should work toward is matching the diameter of the needle to the size of vessel in which it can be used. We'll worry later about other things (like viscosity of fluids and time length I.V. will be in the vein)!!

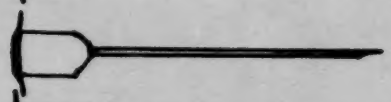
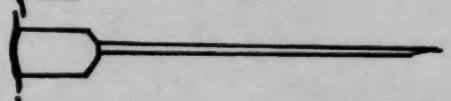
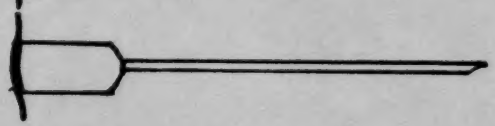
Obviously, the diameter of a needle must be smaller than the vessel diameter since it is threaded into the vessel.

The major thing to remember is that the needle has to be smaller than the vessels.

Practice Question #4:

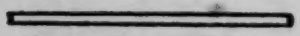
Look at the various diameters of vessels and needles. (Next page and on the table) Each vessel has been lettered - each needle numbered. Beside each letter on the next page, list all the numbers of needles that could be used for the corresponding lettered vessel. A needle may be used for more than one (1) vessel size. Remember, these are just relative sizes.

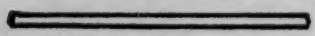
Needles

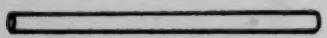
1.
2.
3. 
4. 
5. 

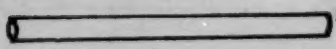
Vessel

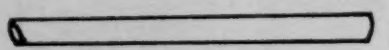
A.

B. 

C. 

D. 

E. 

F. 

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

LOOK ON THE FOLLOWING PAGE FOR YOUR ANSWERS.

Feedback:

Hopefully, you have noticed that the needle has to be smaller than the vessel into which it is to be inserted.

The correct answers you should have listed are:

A. 1

B. 1, 2

C. 1, 2, 3

D. 1, 2, 3, 4

E. 1, 2, 3, 4

F. 1, 2, 3, 4, 5

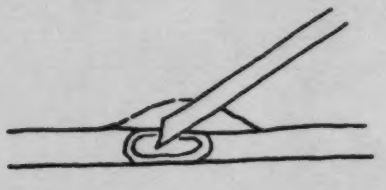
Did you get them right? If not, go back and decide where you went wrong - then try it again!!!

PRACTICE EXERCISE #5

Particular problems can be encountered if the bevel of the needle is positioned incorrectly. Examples of what can happen if incorrectly positioned are illustrated in the first 3 pictures below. Look at them and read the captions of each (large Needle and Small Vein)

INCORRECTLY POSITIONED (Pictures 1, 2, and 3)

1.

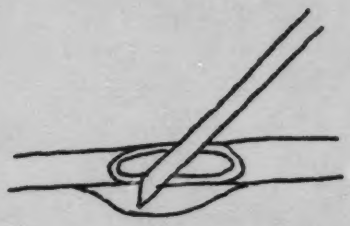


A hemotoma may form if the bevel is up and not completely in the vein due to blood leakage.

2.

The vein may collapse after the tourniquet is released and cover the end of the needle because of immediate pressure changes.

3.



The needle may pierce the backside of the vein and a hematoma may form due to blood leakage.

CORRECTLY POSITIONED (Pictures 4 and 5)

Large Needle and Small Vein

4.

Position the bevel of the needle <u>downward</u> if a relatively <u>large needle size</u> is used for a relative <u>small vein</u>.

Small Needle and Large Vein 5.

Position the bevel of the needle upward if a relatively <u>small needle size</u> is used for a relative <u>large vein</u>.

Now review them again. Make sure you know when the bevel should be up and when it should be down. Proceed to the practice question #5.

Practice Question #5

Demonstrate the position of the needle bevel by drawing on a piece of paper the position when:

a) a relatively large needle is used to enter a relative small vein.

b) a relatively small needle is used to enter a relatively large vein.

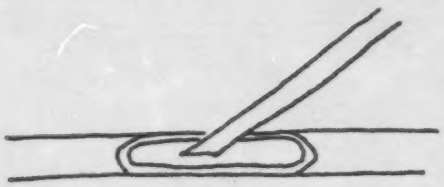
turn the page over to check your answers.....

Feedback

You have it if the pictures you filled in look like these -

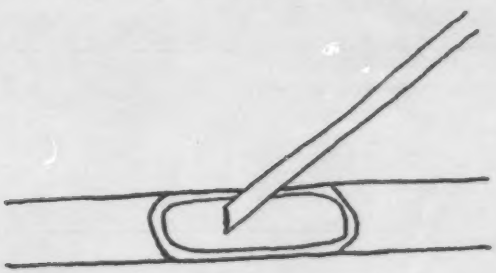
Relatively large needle size in a relative small vein

Bevel down:



Relatively small needle size in a relative large vein.

Bevel up:



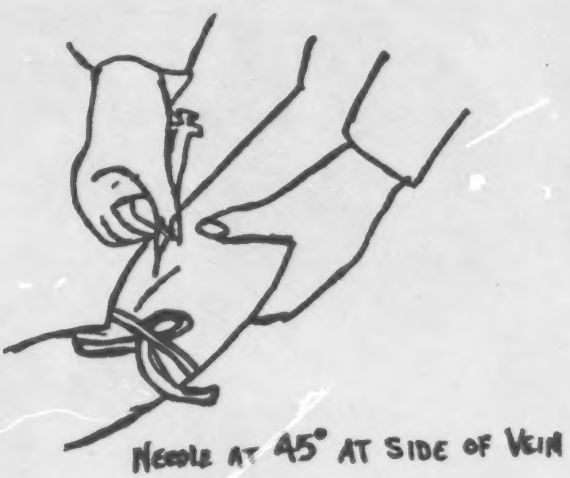
You are ready now for the overall objective.

Proceed!!

PRACTICE EXERCISE FOR OVERALL OBJECTIVE

Now work with the simulated I.V. arm and the syringe and needles. You will need to remember some things you have already learned at this point. Thinking about it - you have already learned where to look for a vein in the hand and arm. Can you visualize where? Try it again! You have practiced palpating the vein and I know you can tell if the vein is healthy or thrombosed. (You can can't you - if you have forgotten, go back to practice question #2.) Locate a vein in the I.V. arm, determine the relative size and decide on a corresponding needle size. Put the needle on the syringe. You may need to put the tourniquet on to determine the size of the vein. Do that now. Are the ends out of your way? With the needle at a 45° angle to the skin, position the bevel of the needle correctly. Up for a large vein, down for a small vein.

Rotate the syringe in your hand until the bevel of the needle is in the correct position.



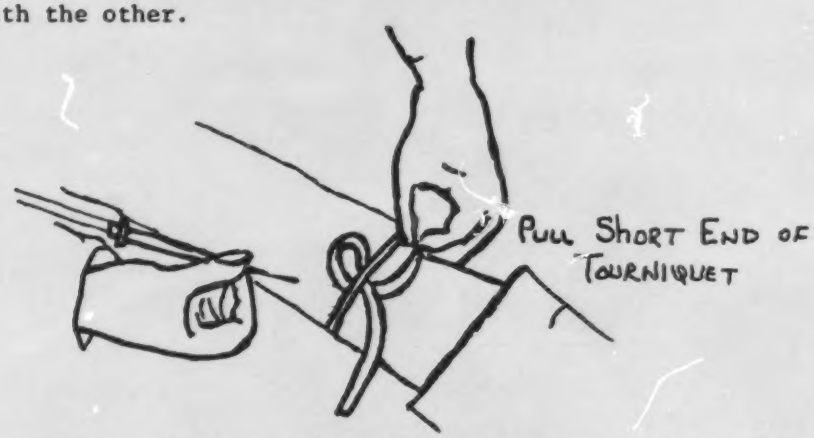
Now you are ready to insert the needle after wiping off the area with alcohol.

WIPE OFF WITH ALCOHOL

Enter the skin just to the side of the vein and about ½" below where you want the needle to be; quickly advance the needle through the skin and to the approximate depth of the vein. Discomfort should only be experienced by the patient when you pierce the skin; he/she should feel no pain under the skin, unless you are near a nerve or ligament. Flatten the angle of the needle and syringe so it is less than 45°. Your needle will be directed so that the fluid flows toward the heart, of course.

LESS THAN 45° ANGLE

Puncture the side of the vein - be careful not to go all the way through it. Your hands are probably sweating now. That's normal the first few times. RELAX - You're doing fine!! Advance the needle slowly following the route of the vein very carefully. You are in! Pull back on the very end of the syringe. If it moves out easily with blood return and can be pushed in easily - you did it. Stabilize the needle with your one hand while you take the tourniquet off with the other.



If you need a minute to relax and compose yourself, do so now. Things are going very well. In the practice question you will need to do the procedure. Reread this section and practice thinking through the steps and rationales until you can visualize them. Before you proceed to the practice questions get someone to check you off on all the steps while you do the procedure. The check list is included on the following page.

Practice Question

Using the I.V. arm as a simulated patient's arm, choose a needle for the vein and insert it properly. Check the steps on the checklist to see if you have done it correctly.

AFTER YOU FINISH THIS - PROCEED TO POST-TEST.

Feedback:

CHECKLIST

a. _____ locate vein

b. _____ palpate vein to determine if it is healthy

c. _____ select the correct needle size

d. _____ apply tourniquet

e. _____ position needle so fluid will travel toward heart

f. _____ position bevel of needle correctly (upward for large vein; downward for small vein)

g. _____ wipe area with alcohol wipe

h. _____ enter skin at side of vein at 45°

i. _____ flatten angle to less than 45°

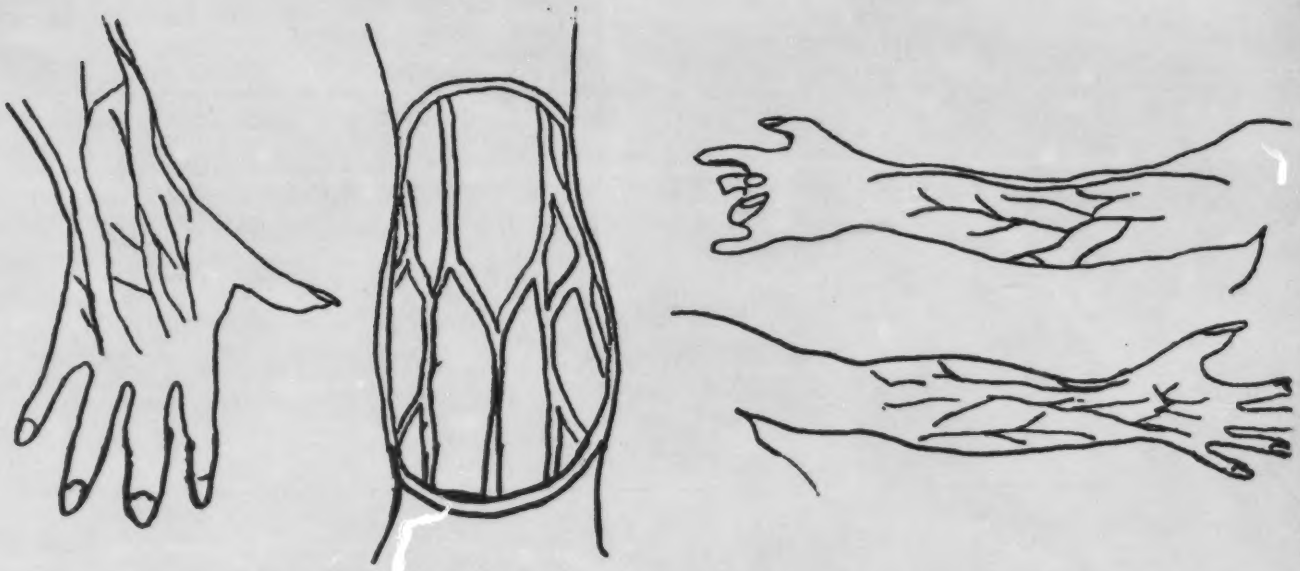
j. _____ look for blood return

k. _____ remove tourniquet

POST-TEST

1. On the diagram (1#) of the hand and arm, indicate with a pencil or pen at least three (3) veins that may be commonly used for I.V. infusion. Which ones can be used to draw blood?

#1



2. Explain in a short sentence the difference in the feel of a healthy vein and a thrombosed vein.

3. On the simulated patient's arm in front of you, correctly insert the proper needle necessary for an I.V. Your partner will mark the checklist.

4. List any benefits gained by the unit materials.

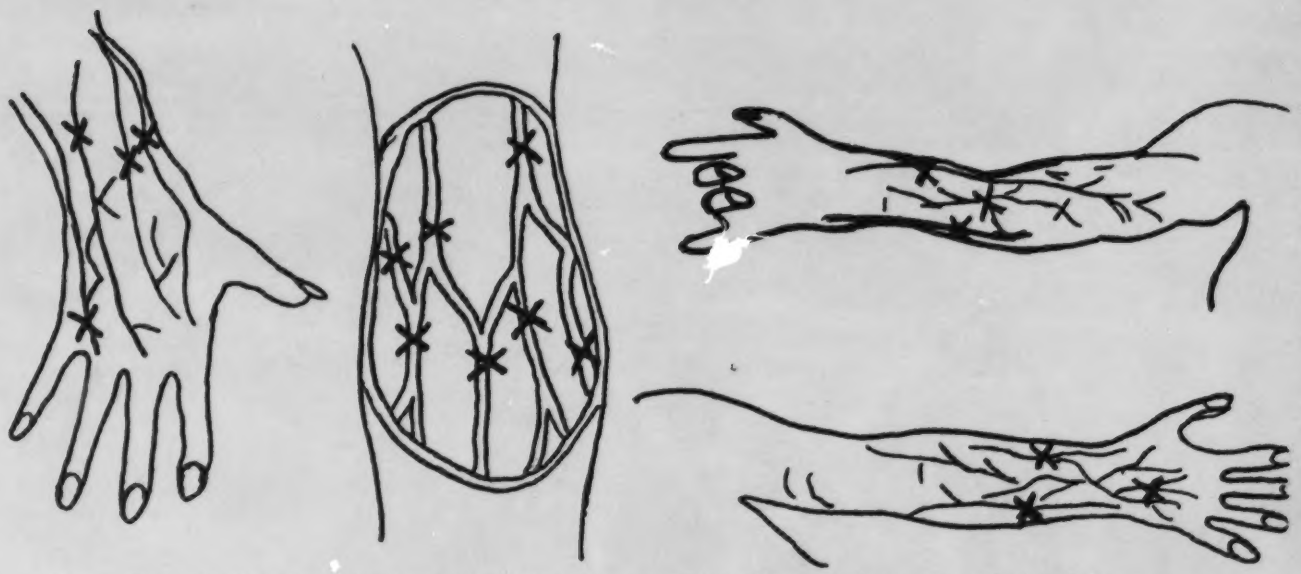
5. Are you more confident in your own skills when starting an I.V.?

Fill in the position of the mouth of the face.

turn the page and check your answers

ANSWERS TO POST-TEST

1. You are right if you have included any three of the veins checked on the diagram below:



2. You could consider your answer correct if it contains something like healthy vessels when lightly palpated will have recoil properties (elastic) whereas, a thrombosed vein will feel hard to the fingertips.

3. You have done it correctly, if you have:

   A. Selected veins that can be used for an I.V. (look at the above diagram)

   B. Palpated the vein to determine if it has elastic properties.

   C. Chosen a needle size of 16, 18 or 21 gauge

   D. Applied a tourniquet properly.

   E. Positioned the needle so fluid will travel toward the heart.

   F. Positioned the bevel of the needle upward if a relatively small needle size was used for a relative large vein.

   G. Positioned the bevel of the needle downward if a relatively large size was used for a relative small vein.

   H. Threaded the needle into the vein and have blood returned.

   I. Removed the tourniquet.

4. Some possible benefits might include:

   A. I can do it now

   B. I feel more relaxed when doing it

   C. It's a good review

   D. It can be used by different people at different times

5. Hopefully by now, your answer is yes.

HAVE A NICE DAY!!

HEALTH INSTRUCTION EXCHANGE
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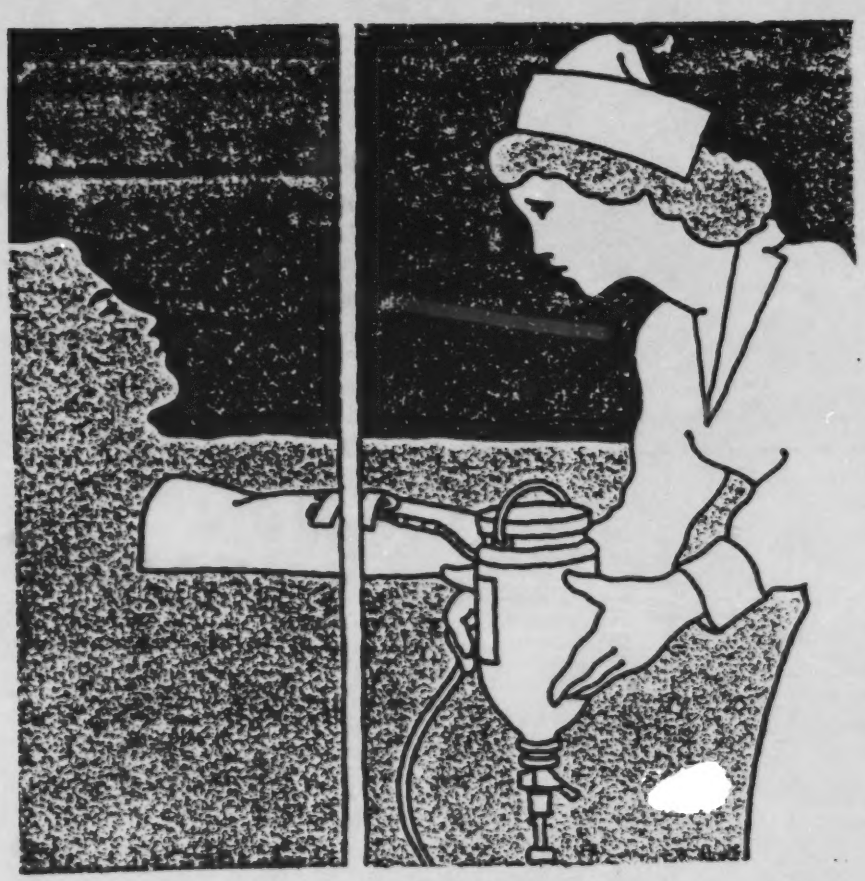
A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

TECHNIQUES IN STARTING INTRAVENOUS THERAPY

by

J. SUE BELDIN, RN, AA, BA



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TITLE OF PACKAGE:	Techniques in Starting Intravenous Therapy: Parts I and II.
AUTHOR:	J. Sue Beldin
INSTITUTION:	Good Samaritan Hospital, San Jose, Calif.
INTENDED STUDENTS:	1. Trained Resistered Nurses; 2. Possibly L.V.N. with a prerequisite of a pharmacology course
ESTIMATED WORKING TIME:	30 minutes per part
MATERIALS NEEDED:	1. I.V. solution 2. I.V. tubing 3. Straight needles # s 16, 18, 20, 22 4. Angiocath #s 18, 20 5. Intrafusor #s 17, 19, 21 6. 2" x 2" dressing 7. 4" x 4" dressing 8. Tourniquet 9. Topical antibacterial ointment 10. Alcohol sponges 11. 1/2" tape (paper) 12. 2" tape (paper) 13. Emesis basin 14. Model Arm by Nasco - Med. Inj. Training Arm Model LF 698 - Serial # 1274009 15. Distilled Water

FIELD TEST COPY

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INTRODUCTION

To Fellow R.N.s:

How many of you have been out of school one year, five years, and have not learned the techniques in starting I.V.s? Do I hear,

"I never learned during my training"

OR

"I was in a teaching hospital and only the residents and interns were allowed to start I.V.s"

OR

"There is no one who has time to teach me"?

I've been there and know what you're saying and do empathize with you.

Here is a two-part learning module to instruct you on intravenous techniques which involves types of equipment, set-up, prepping the patient emotionally and physically, and the actual stick on a Model Arm as well as a follow-up clearance procedure that one might follow in his or her hospital.

TECHNIQUES IN STARTING INTRAVENOUS THERAPY

Overall Objective

The nurse will be able to start intravenous therapy on a patient.

Sub-Objectives

1. Describe how to check asepsis of I.V. fluid.
2. Describe the different types of equipment used to place in a vein:

   Straight needle

   Over-the-needle catheter

   Thru-the-needle catheter
3. Demonstrate correct way to set up the administration of I.V. solution and respective equipment.
4. Describe explanation of I.V. therapy to patient.
5. Demonstrate the aseptic technique of preparation of site on patient.
6. Demonstrate the technique in starting an I.V. infusion with an over-the-needle and thru-the-needle catheter (on a model), as well as demonstrate ability to secure and label the intravenous catheters and tubing for maximum stabilization and information concerning date, time, and size of catheter used.
7. After above demonstrations, describe how to use I.V. check off card to be cleared officially to start I.V.s throughout hospital.

PART I

OBJECTIVES 1-4

EXERCISE #1

Three things to be checked to insure sterility of I.V. bottle are:

a. Crack in bottle.

b. Particulate matter floating in bottle.

c. Cap on bottle sealed inappropriately.

1. Without looking back, list the three things you would look for when checking sterility of I.V. solution.

Answers

1a. Crack in bottle.

b. Particulate matter floating in bottle.

c. Cap on bottle sealed inappropriately.

EXERCISE #2

Here are three types of needles used in starting I.V.s:

a. Straight needle (usually size 22, 20 and 18)

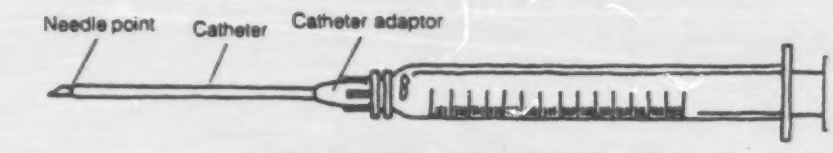
b. Over-the-needle catheter - a synthetic plastic tubing placed over the needle

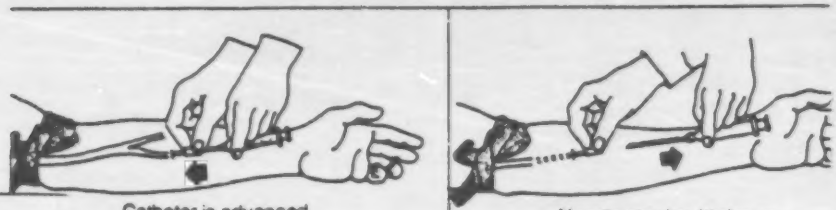
c. Thru-the-needle catheter - a synthetic plastic catheter passed through the needle.

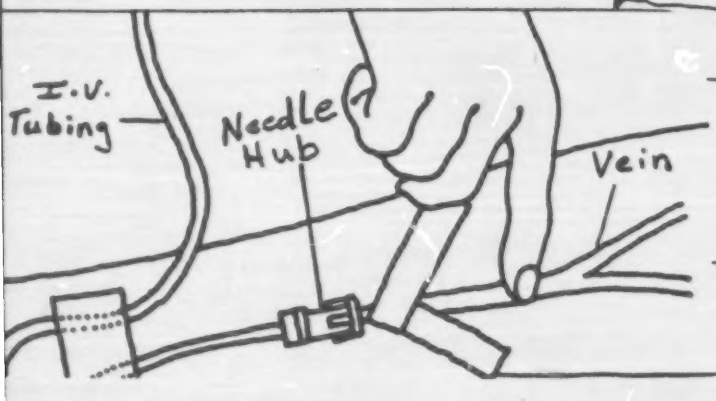
Straight needle:

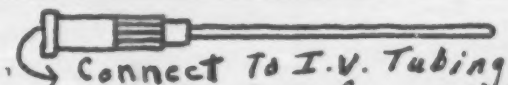
Simply threaded through vein by insertor.

Over-the-needle:



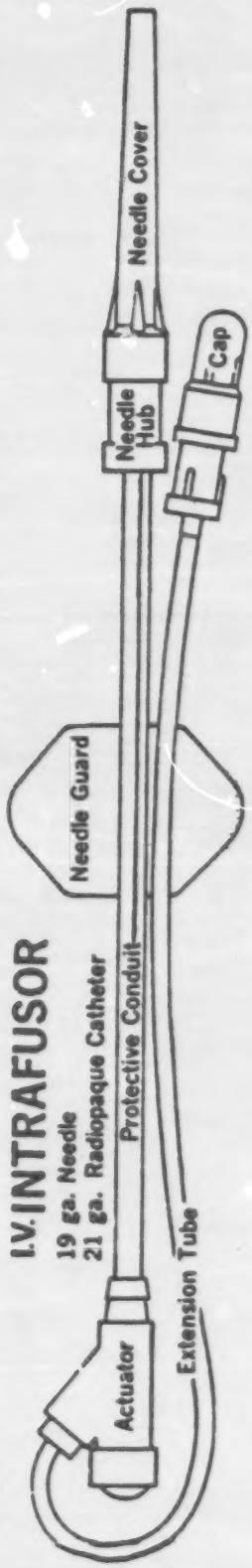






Cross Tape Method

Thru-the-needle:



1. Remove cap and connect end to see syringe filled with sterile H_2O and flush

   OR

2. Connect to I.V. tubing - open, shut off valve and flush catheter.
3. Remove cap and insert needle into vein. Note if blood returns in radiopaque.
4. Hold needle hub stable with one hand and push actuato to needle hub. Lock in place with the sound of a click.
5. The protective conduit will be extending from the actuator and is to be pulled away from actuator and disposed of.
6. Place 1/2" tape under needle - pull out needle and tubing 1-1/2 to 2 inches and cross tape as shown.
7. Place needle guard half on needle and half on radiopaque tubing and fold clamp and clip shut.

Note: Be careful not to clamp off tubing when clipping shut guard.

2. Identify three types of equipment inserted in vein and show the mechanics of same.

Answer

Check your memory with the input material of pages 3 and 4.

EXERCISE #3

The following is a list of equipment used to set up for starting I.V.

A. I.V.Bottle

B. I.V.Tubing

C. Needle or catheter

D. Co-worker or instructor

a. You have already checked for sterility of solution.

b. Remove cap from bottle.

c. Take I.V. tubing and insert end with fluid chamber into bottle while bottle is sitting on table.

d. Close shut-off clamp.

e. Turn bottle upside down and hang on I.V. pole.

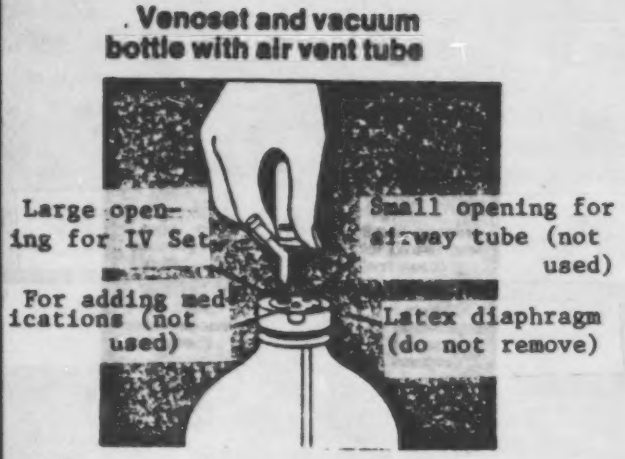
f. Squeeze fluid chamber in order to fill to half full.

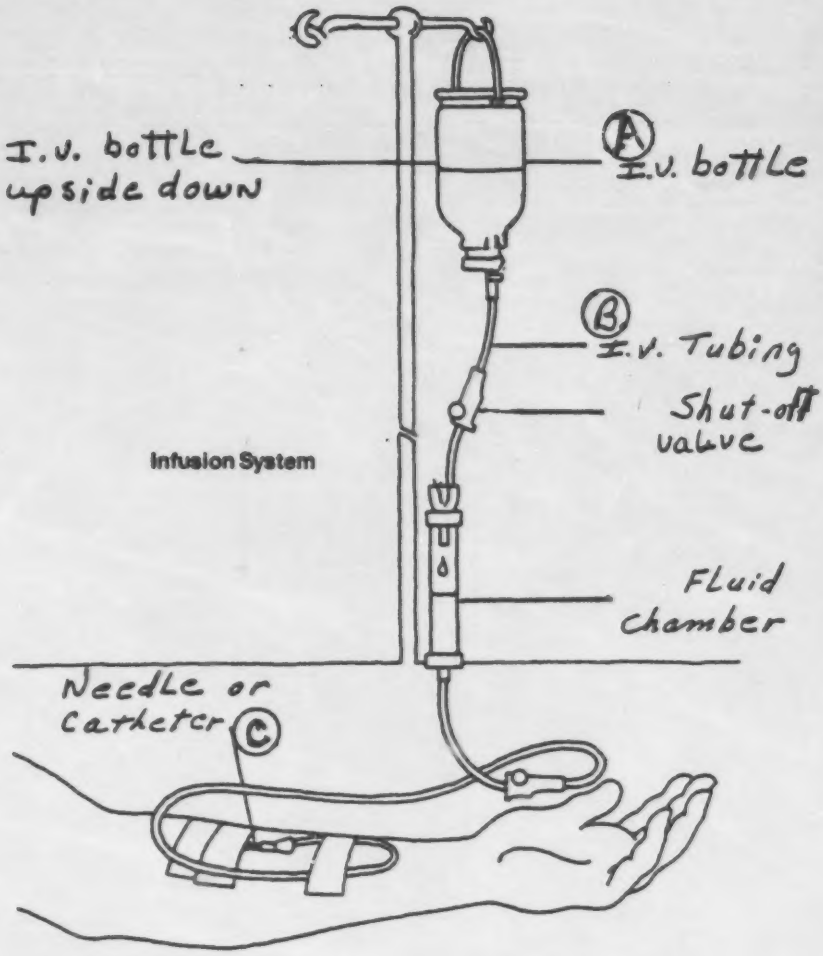
g. Place needle or catheter on the other end of tubing.

h. Open shut-off clamp and allow only enough fluid to run through needle with no bubbles in I.V. tubing.

3. Study the illustrations on the next page. Then test your memory by listing the materials you'll need for setting up an I.V.

GRAPHIC OF I.V. EQUIPMENT


Venoset and vacuum bottle with air vent tube
Large opening for IV Set
Small opening for airway tube (not used)
For adding medications (not used)
Latex diaphragm (do not remove)



Answer

A. I.V. Bottle

B. I.V. Tubing

C. Needle or catheter

D. Co-worker or instructor

EXERCISE #4

The procedure should be explained to the patient by the following:

a. Your doctor has ordered an I.V.

b. Have you ever had such a procedure?

c. I shall place a needle in a vein in your arm in order for this fluid to run in.

d. This will be taped well and should not be too uncomfortable once in place.

e. Allow patient to ask any questions.

4. Without looking back, write in your own words the five points you should cover in your explanation to the patient.

Answer

a. Your doctor has ordered an I.V.

b. Have you ever had such a procedure?

c. I shall place a needle in a vein in your arm in order for this fluid to run in.

d. This will be taped well and should not be too uncomfortable once in place.

e. Allow patient to ask any questions.

Before continuing to Part II, which is a demonstration exercise, turn to Page 15 and take the short Post-Test for Part I. Check your answers on Page 16. Then return to Page 9 to begin Part II.

PART II

OBJECTIVES 5-7

EXERCISES 5 and 6

These are the stages one takes when prepping and starting I.V. on the Model Arm. Note: Try and work through the process with the materials at hand.

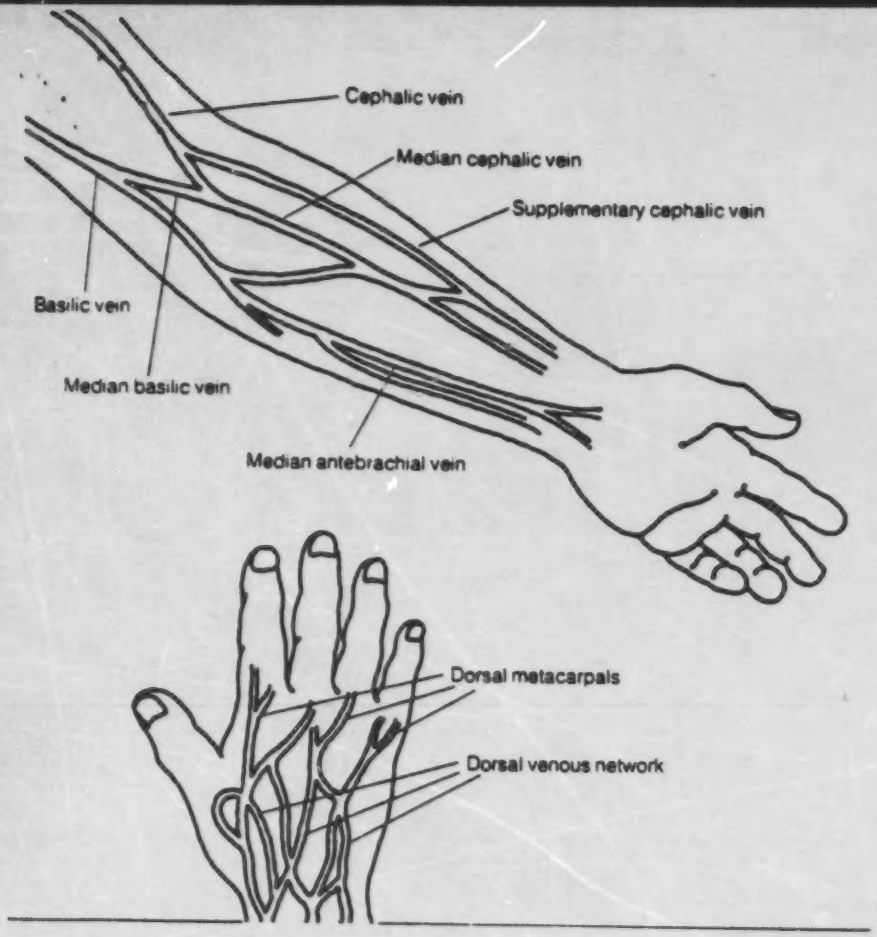
1. Set up I.V. bottle and tubing.
2. Inssmall tray place:

1 roll 2" tape	1 roll 1/2" tape
4 2"/2" gauze dressings	4 4"/4" gauze dressings
Alcohol sponges	Neosporin ointment
Tourniquet	Straight Needle (Size 22/20/18)
Over-the-needle Catheter, Size 20	Through-the-needle Catheter, Size 19

3. a. Cut three pieces of 2" tape 3" long and hang on I.V. pole.
   b. Cut one piece of 1/2" tape 3" long.
   c. Have ointment ready.
   d. Have gauze ready.
   e. Have I.V. set up and choice of needle ready and primed.
4. Study the illustrations on Page 10. Then:
   a. Take alcohol sponge and prep at least 3" area on the arm or hand. Apply alcohol to your fingers on the hand used to find or stabilize the patient's arm or hand. If the site chosen is extremely hairy, shave the area.
   b. Apply tourniquet. (Caution: if applied too tightly, the tourniquet could cause vein to collapse.

IMPORTANT! Take your time in finding a good vein.

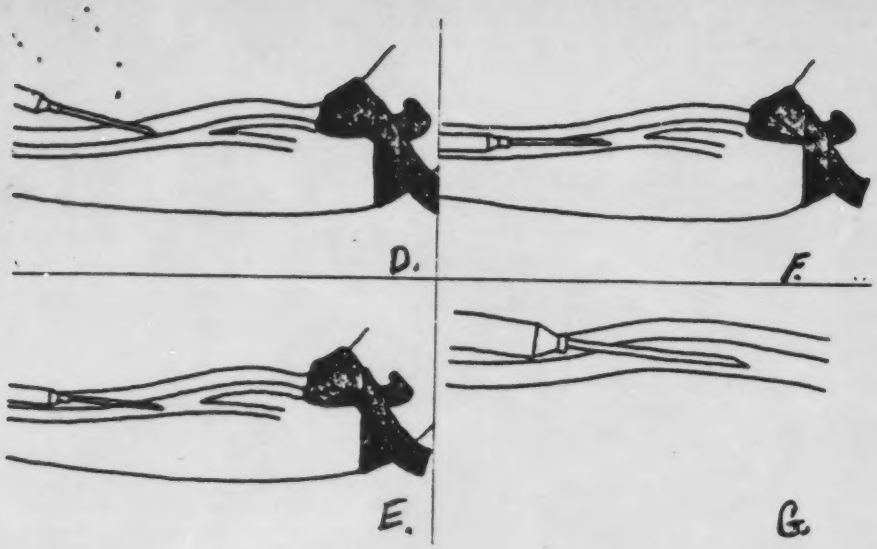
Anatomy of Veins
In Arm and Hand



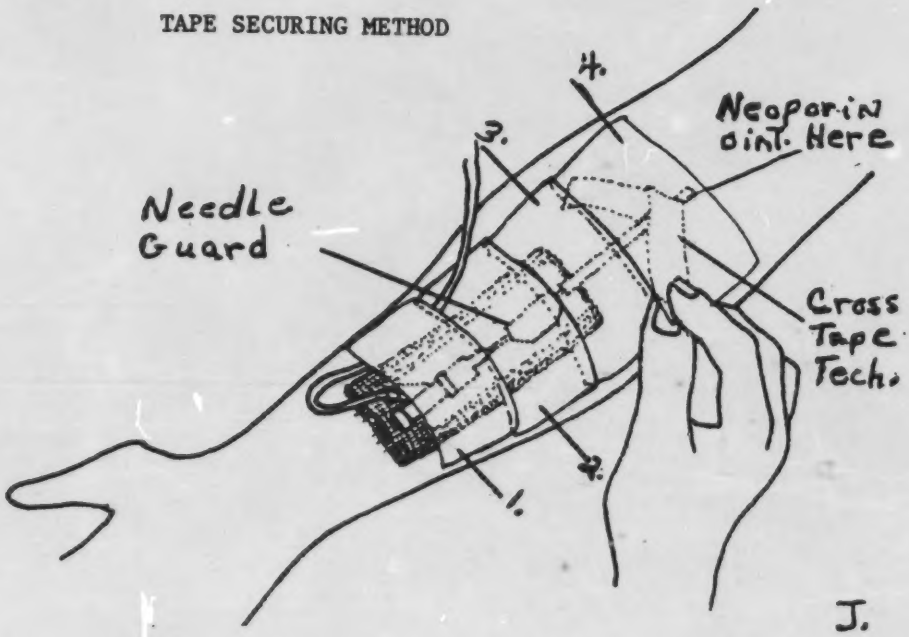
A.

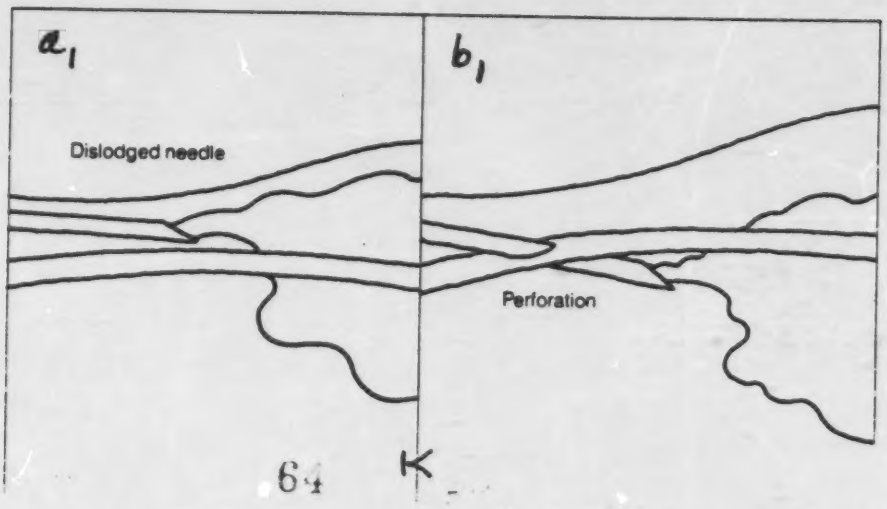
B.

C.



TAPE SECURING METHOD





C. Hold needle hub firmly with hand, bevel side up, in the direction of venous flow and positioned slightly to one side, approximately 1/2" below the selected site for vein entry.

D. The skin is pierced at an angle--the needle tip reaching but not penetrating vein.

E. The vein is entered slowly.

F. Patency verified by the appearance of a backflow of blood.

G. The needle is advanced slowly so that it lies well within the vessel.

H. Remove tourniquet.

I. If needle already attached to I.V. tubing, open shut-off valve to clear line and maintain patency while stabilizing line.

J. Stabilize as directed

a. Cross tape.

b. Neosporin applied at site of stick.

c. Place gauze dressing underneath guard and connection of needle and I.V. tubing.

d. Place 3 to 4 pieces of tape as shown 1, 2, 3, 4.

**e. On last piece of tape (before applying) write:

Needle and size used

Date

Time

K. Note hazard and risks of I.V. Procedure a_1 and b_1.

L. Check to see if I.V. is in place as needed.

7.L. Check to see if I.V. is in place as needed.

*****REASONS TO DISCONTINUE I.V.:

1. Is site swollen and/or red?
2. When bottle is lowered, there is no blood return.
3. Patient complaining severely of pain and discomfort.

5 & 6. It is now your turn to start an I.V. on the Model Arm:

Remember:
a. Find vein & take your time.
b. Prepping site.
c. Inserting needle or catheter.
d. Stabilizing and labeling the infusion.

Answer

Check your technique with the directions and illustrations on pages 9-13.

EXERCISE #7

Here is a suggestion as to a format to be checked-off officially in starting I.V.

1. Obtain I.V. card from instructor.
2. Attempt and be successful in starting 3 I.V. s with over-the-needle and thru-the-needle catheters with qualified observer watching.
3. Have qualified, designated person sign bottom of card where it says, "Cleared to start I.V. s."
4. Hand card in to appropriate person.

7. Without looking back, list the four steps you will take to be officially cleared to start I.V. s.

Answer

Your words will be different, but the four points should agree with those given at the start of Exercise 7.

Now turn to Page 15 to check your memory with Part II of the Post-Test.

POST TEST

ORAL AND PRACTICAL WITH SUPERVISION

Part I

1. What three things would you look for in checking sterility of I.V. solution?

2. Identify three types of equipment inserted in vein and show mechanics of same.

3. Go to box and demonstrate how to set up I.V. equipment.

4. Should you explain procedure to patient? Explain.

Part II - Instructor present

5. Start I.V. on "model arm" involving:

6. a. Finding vein.

   b. Prepping site.

   c. Inserting needle or catheter.

   d. Stabilizing and labeling the infusion.

7. State how one is officially cleared to start I.V. on the floor.

ANSWERS TO POST-TEST

PART I

1. a. Crack in bottle

   b. Particulate matter floating in bottle.

   c. Check and see that cap on bottle is sealed appropriately.

2. See Pages 3 and 4.

3. Demonstration. Check back to Pages 6 and 6A.

4. See Page 7.

PART II

5 and 6 - Demonstration. Check your performance with the input on Pages 9-13.

7. You're right if your words agreed with the four points listed on Page 14.

CONCLUSION!

OKAY PEOPLE -- ALTHOUGH YOUR FEARS PREVAIL, YOU ARE READY TO TAKE THE "BULL BY THE HORNS" AND PERFECT YOUR TECHNIQUE. *** HINT: REMEMBER, THE MORE PRACTICE YOU HAVE AND THE MORE YOU WATCH OTHER'S TECHNIQUE, THE SOONER YOU WILL DEVELOP YOUR OWN STYLE AND EXPERTISE.

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A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

CALCULATING THE RATE OF FLOW OF INTRAVENOUS FLUIDS

by

Cynthia A. Hulse

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TITLE:	Calculating Rate of Flow for Intravenous Fluids
AUTHOR:	Cynthia A. Hulse
INSTITUTION:	Ann May School of Nursing, Eatontown, NJ
INTENDED STUDENTS:	First year R.N.
ESTIMATED WORKING TIME:	60 minutes
MATERIALS NEEDED:	IV tubing boxes with sets that deliver 1) Travenol = 10 gtt/cc; 2) McGaw = 15 gtt/cc; 3) Cutter = 20 gtt/cc; 4) Travenol Buretrol = 60 gtt/cc.
REVISED:	Nov. 15, 1977

REFERENCE

Lawrence, Ada. Principles and Practice of Intravenous Therapy. Little, Brown and Co. Boston. 2nd Edition.

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INTRODUCTION

Have you ever looked at an IV and wondered if you really calculated the rate correctly? Do formulas confuse you? Do you forget them? Do questions like: "When will the IV be finished?" and "How many drops/minute is the IV running?" upset and frustrate you??

This package is designed to assist you in finding the answers to these questions.

Interested...Turn the page →

Overall Objective

Upon completion of this unit you will be able to calculate the rate of flow of IV fluids.

Sub-objectives

You will:

1. State the formula for calculating the rate of flow for IV fluids;
2. State where to find the number of drops per milliliter that an IV set delivers;
3. Identify the IV set that provides precision control;
4. Relate why a continuous flow is necessary to keep a vein open;
5. Given a specific amount of fluid and the time of day, calculate when the IV bottle will be empty.
6. Calculate the number of drops/min by utilizing the basic formulas.

PRACTICE EXERCISE #1

Input

We will begin by studying the basic formula that you will need in order to calculate any rate of flow for IV fluids.

$$\frac{\text{Total Volume To Be Infused x drops/cc}}{\text{60 minutes x Total Time of Infusion in Hours}} = \text{drops/min}$$

So, in order for you to calculate the number of drops/minute, you need to know: 1) the total volume to be infused; 2) the length of time it is to be infused; and 3) how many drops/cc that the IV set delivers.

- That sounds like a lot

But, relax! All of that information is given to you!!

Practice Question

The physician will always order the amount and type of solution and the length of time.

Like this...1000cc D_5W q8h

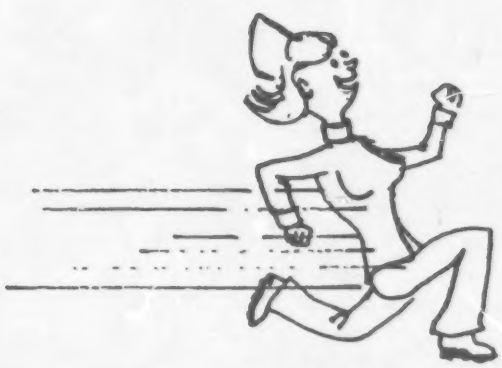
Using this information, fill in as much of the formula as you can.

Feedback

If you answered $\frac{\text{1000cc x}}{\text{60 min x 8 hours}}$

You are correct.

Now move on to the next practice exercise.

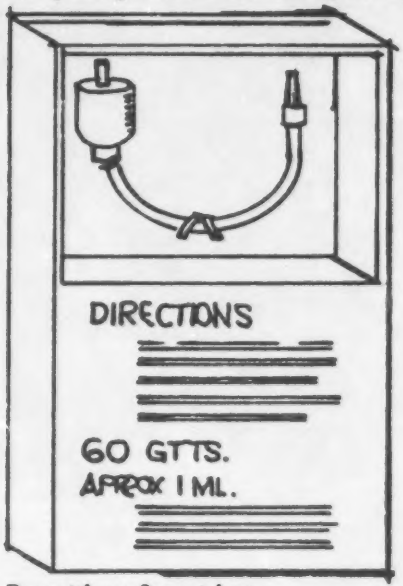


PRACTICE EXERCISE #2

Input

Now, in order to complete our formula (a part that the physician's order doesn't include), we need to know gtts/cc. Where might we find that information?

If you guessed on the package of the IV tubing, you are correct.



You will usually find the number of gtts/cc that an IV set delivers on the back of the box. NOTE: If the box does not indicate the number of gtts/cc, it is assumed that it is 15 gtts/ml.

Practice Question

Take a few minutes to look at the IV tubing boxes provided for you and indicate the number of gtts/cc each set delivers.

A _____ gtts/cc

B _____ gtts/cc

C _____ gtts/cc

Feedback

A 10
B 15
C 20

You got all of those correct.

Great! Now you have all the information you need to finish the formula.

Ready to try it...

Turn the page.

PRACTICE EXERCISE #3

Input

The order reads 1000cc D_5W q8h. Suppose we have a 10 gtt/cc set.

First remember the formula $$\frac{\text{Total Volume to be infused x drops/cc}}{\text{60 minutes x Total time of infusion in hours}}$$

Then fill in the information.

$$\frac{1000\text{cc x 10 gtt/cc}}{\text{60 minutes x 8 hours}}$$

Now reduce wherever possible.

$$\frac{\overset{125}{\cancel{1000}}\text{cc x } \overset{1}{\cancel{10}}\text{ gtt/cc}}{\underset{6}{\cancel{60}}\text{ minutes x } \underset{1}{\cancel{8}}\text{ hours}}$$

Then complete the formula $\frac{125}{6}$ = 20.8 or 21 gtts/min

Practice Question

Now you try the same IV order with

A. a 15 gtt/cc set

B. a 20 gtt/cc set

Feedback Is this how you set it up?

A. $$\frac{\overset{125}{\cancel{1000}}\text{cc x } \overset{1}{\cancel{15}}\text{ gtt/cc}}{\underset{4}{\cancel{60}}\text{ minutes x } \underset{1}{\cancel{8}}\text{ hours}} = 31.25 \text{ or } \boxed{31 \text{ gtts/min}}$$

You are correct!

PRACTICE EXERCISE #3 (cont.)

B. $$\frac{125 \quad 1}{\cancel{1000}\text{cc} \times \cancel{20}\ \text{gtt/cc}} = 41.6 \text{ or } \boxed{42 \text{ gtts/min}}$$
$$\frac{\cancel{60}\ \text{minutes} \times \cancel{3}\ \text{hours}}{3 \quad 1}$$

If you got both of the answers correct, that's great...Keep going!

Many students find this the hardest part, so if you didn't get the correct answer, review the formula, check your math, and try it again.

You can do it!

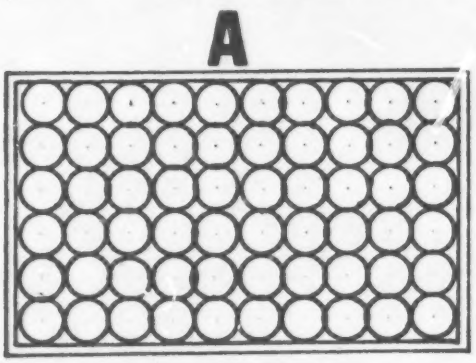
PRACTICE EXERCISE #4

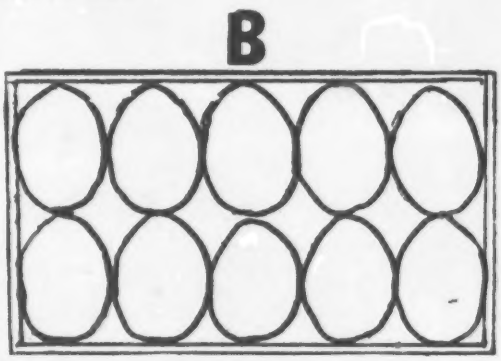
Input

Have you been wondering why you need different IV sets that deliver different drops/cc? Why can't you just have one set that can be used for anyone? Well, there are times as you will find out during your course of study that precision control of the rate of flow of an IV is essential. IV sets that deliver a smaller drop like a 60 drops/cc set provide that precision. An important concept to remember is that intravenous fluids must be dripping at a constant rate of flow in order to keep the vein open. Without the constant flow blood would clot in the tubing. If you have a 60 drop set, you could slow the IV considerably and still maintain a continuous flow.

Still confused?

Well, consider this diagram and suppose you were to give 1 milliliter of fluid in 1 minute. The boxes below both contain 1 milliliter of fluid. Box A is using a 60 gtt/cc set and Box B is using a 10 gtt/cc set.





The 60 gtt/cc set would deliver 1 drop every second. while The 10 gtt/cc set would deliver 1 drop every 6 seconds.

If you had to give a small amount of fluid per minute, you would choose the 60 gtt/cc set because you could maintain a continuous flow at a slow rate and still keep the vein open.

PRACTICE EXERCISE #4 (cont.)

Practice Question

a. When administering a small amount of IV fluid, which one of these IV sets would you use?

b. Why is it important to maintain a continuous flow?

Feedback

a. 60 gtt/cc set

b. a continuous flow at a regular rate will keep the vein open and prevent blood from clotting in the tubing.

NOTE: There are a variety of reasons why precision control may be necessary. The patient's age, condition, the type of solution being used, medications, etc., may require precision control. You will learn about these during your studies.

PRACTICE EXERCISE #5

Input

Before you complete this program, I want you to consider a common situation that occurs in the hospital.

SITUATION:

You report to work at 7 a.m. and check the IV, and there is 500cc left in the bottle. After checking the order which reads 1000cc b_5w q8h, you want to know when the bottle will be finished so you can prepare the next bottle at that time.

First, take a closer look. You know the order reads 1000cc q8h, so, in 1 hour you must give x cc's.

Like this: $\frac{1000cc}{8h} = 125cc/hr.$

Second, if you have 500cc left in the bottle and you have calculated the rate at 125cc/hr then it's simple...just divide the number of cc's/hour into the amount you have left in the bottle.

$$\frac{500cc}{125cc/hr} = 4 \text{ hours}$$

You can then figure out that the bottle will be finished at 11 a.m.

Practice Question

Now you try one...

You report to work at 11 p.m. and your patient has 200cc of solution left in his bottle. The physician's order reads 500cc q 10h. In the space below -

a. Calculate the number of cc's to be infused in one hour.

b. Calculate how many hours the bottle will last.

c. What time will the bottle be empty?

Feedback

Is your answer 3 a.m.?

If so, you are ahead of the game. Turn to Page 12.

If you didn't answer correctly, try this one -

Your order reads 1000cc q8h. You have 600cc left in the bottle. How many hours until that bottle is finished?

1. Calculate the number of cc/hour.

2. Calculate how many hours the bottle will last.

Step #1 should look like this:

$$\frac{1000cc}{8\ hrs} = 125\ cc/hr$$

Step #2 - You should have divided the number of cc/hr from Step 1 into the number of cc's left in the bottle -

$$\frac{600cc}{125cc/hr} = 4.8\ hours$$

Now, go back to the first problem in Practice Question 5 and try it again.

PRACTICE EXERCISE #6

Practice Question

Utilizing all the information you have gained, calculate the rate of flow of the IV in the following situation:

> The physician has ordered 500cc D_5 Electrolyte #75 q8h for an infant. You are to use a 60 gtt/cc set. Calculate the rate of flow.

Feedback

63 gtts/min - you're right - Are you ready for the post-test? Good luck!

If you didn't get the answer, don't despair - Did you set up the problem like this:

$$\frac{\overset{125}{\cancel{500}\text{cc} \times \cancel{60}\ \text{gtts/cc}}}{\cancel{60}\ \text{min} \times \underset{2}{\cancel{8}\ \text{hrs}}} = 62.5 \text{ or } 63 \text{ gtts/min}$$

If you did set it up right, then check your math and try again.

Want more practice?

Try this one --

> The order reads 1000cc g12h. You have a 15 gtt/cc set available. Calculate the rate of flow.

Feedback

Your calculations should look like this:

$$\frac{\overset{250}{\cancel{1000}\text{cc} \times \underset{1}{\cancel{15}\ \text{gtt/cc}}}}{\underset{4}{\cancel{60}\ \text{min}} \times \underset{3}{\cancel{12}\ \text{hrs.}}} = \frac{250}{12} = 20.83 = 21 \text{ gtts/min}$$

Now, you are ready for the Post-Test...Good luck!

POST-TEST

1. In the space below state the formula for calculating the rate of flow for IV fluids.

2. If in doubt about the number of drops/cc that an IV set delivers, where would you find this information?

3. Which of the following IV sets would deliver a small amount of fluid at a continuous rate of flow and still keep the vein open:

   a. 10 gtt/cc set
   b. 15 gtt/cc set
   c. 20 gtt/cc set
   d. 60 gtt/cc set

4. The physician calls you at 10 a.m. on the phone and asks when the IV solution will be finished on his patient. The order reads: 1000 cc D_5W q10h. You note that 300cc is left in the bottle. You are using a 10 gtt/cc set.

   a. How many hours will it take to finish?
   b. What time will it be finished?

5. Calculate the correct flow rate for the following orders:

   Using a 15 gtt/cc set

   a. 1000cc D_5/.45NS q6h

   b. 500cc D_5RL q8h

   Using a 10 gtt/cc set

   c. 1000cc D_5/.33NS q10h

   d. 500cc D_5W q4h

   Using a 60 gtt/cc set

   e. 1000cc D_5 1/2NS q10h

   f. 250cc $D_{10}W$ q6h

POST-TEST ANSWERS

1. $\frac{\text{Total Volume to be infused x gtts/cc}}{\text{60 minutes x Total volume of infusion in hours}}$

2. On the back of the box. If it is not there, it is assumed that it is 15 gtt/cc.

3. d

4. a. 3 hours
   b. 1 p.m.

5. a. 42 gtts/min
   b. 16 gtts/min
   c. 17 gtts/min
   d. 21 gtts/min
   e. 100 gtts/min
   f. 42 gtts/min

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